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ABSTRACT

This paper reviews the research literature regarding the importance of Witkin's theory of psychological differentiation, particularly the research on measures of field independence using perceptual disembedding tasks. The first phase of development of a multiple-choice perceptual disembedding measure, the Finding Embedded Figures Test, is reported. The literature exploring the origins of cognitive style differences is also summarized. The paper reports research evaluating the quality of a new pool of items that can be used in multiple-choice, machine-scorable measures of field independence. Most previous research has utilized the Group Embedded Figures Test, a supply-format test requiring judgments to be made in assigning scores. Results are interpreted in the development of two forms of the new measure. An extensive bibliography is appended. (Author/TJH)

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MEASUREMENT CHARACTERISTICS OF A TEST OF FIELD-INDEPENDENCE: LITERATURE REVIEW AND DEVELOPMENT OF THE FINDING EMBEDDED FIGURES TEST

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ABSTRACT

The paper reviews the research literature regarding the importance of Witkin's theory of psychological differentiation, particularly the research involving measures of field independence using perceptual disembedding tasks. The literature exploring the origins of cognitive style differences is also summarized. The paper reports research evaluating the quality of a new pool of items that can be used in multiple-choice, machine-scoreable measures of field independence. Most previous research has utilized the Group Embedded Figures Test, a supply-format test requiring judgments to be made in assigning scores. Results are interpreted in the development of two forms of the new measure. An extensive bibliography is appended.

In the years immediately following World War II, Herman A. Witkin and his colleagues performed a series of historically important studies (e.g., Witkin, 1949) involving stylistic variations in perceptions of visual stimuli. These initial studies investigated variations in ability to perceive the upright in the absence of normally-available orienting stimuli. Witkin, Moore, Goodenough and Cox (1977, pp. 3-4) present photographs of the appartuses used in these early "rod-and-frame" and "body-adjustment" tests. Heesacker (1981) presents a summary of the early years of this important research, and of the antecedents of the work dating back to the previous century (Jastrow, 1892).

This early work led to the development of the theory of psychological differentiation and the delineation of a cognitive style that has come to be called field independence/dependence. As noted by Goodenough and Witkin (1977, pp. 2-3),

> Field dependence-independence has its conceptual home in the broader theory of psychological differentiation... Greater differentiation implies the formation of articulated subsystems within the organism, capable of carrying out specific functions in specialized fashion... With increasing self-nonself segregation internal referents become available as guides to behavior... The tendency to rely primarily on internal referents in information processing has been called a field-independent cognitive style.

As Witkin (1979, p. 359) notes,

> We designate the tendency to rely on the self as a primary referent in information processing as a field-independent mode of functioning and the tendency to rely on external referents as a field-dependent mode of functioning. These tendencies find widespread expression in an individual's perceptual, intellectual, and social activities.

Persons who tend to operate on the field independence (FI) end of this cognitive style continuum tend to perceive themselves as more segregated from their environments; these persons tend to be more analytical in their abilities and interests.

Persons who tend to operate on the field dependence (FD) end of the continuum, on the other hand, tend to be less able to either distinguish among or reorganize stimuli. More field dependent persons also tend to be more social in their abilities and interests. Thus, more field-dependent persons have a greater preference to be with people (Bard, 1972; Coates, Lord & Jakobovics, 1975) and may be more popular with their peers (Wong, 1976). Similarly, more field-dependent persons may be more attentive to social cues (Eagle, Goldberger & Breitman, 1969; Fitzgibbons & Goldberger, 1971; Ruble & Nakamura, 1972) and may even prefer to be physically closer to other people (Holley, 1972; Justice, 1969). In summary, as Jacobs and Gedeon (1982, p. 19) explain,

> Field independent persons are those who tend to process information with greater isolation from their environment. Thus, they have been shown to

have less sensitivity to social cues and less developed interpersonal skills; they tend to process information more analytically since parts of their environment are more apparent to them.

Field independence is the most researched of the 19 cognitive styles that have been identified (Goldstein & Blackmun, 1978; Messick, 1976). For example, a comprehensive bibliography of studies involving the field-independence construct cites several thousand studies (Cox & Gall, 1981). Various researchers concur that the construct of field-independence has stimulated great interest:

> The concepts and methods derived from work on cognitive style over the past two-and-a-half decades are being applied at an ever increasing rate to research on problems of education. Among the cognitive styles identified to date, the field-dependence-independence dimension has been the most extensively studied and has had the widest application to educational problems. (Witkin, Moore, Goodenough & Cox, 1977, p. 1)
>
> Of the several cognitive style dimensions thus far identified in the research literature, field dependence-independence has received the most attention. (Laosa, 1978, p. 3)
>
> Although a fairly diverse range of cognitive styles has been identified (Impulsiveness-restraint, Flexibility-rigidity) the most heavily

researched cognitive style by far has been the field independence-dependence dimension. (Donlon, 1977, p. 1)

Cognitive style research is being applied at an ever increasing rate to the problems of education. The field-dependence/field-independence dimension described by Witkin and his associates has been one of the most widely studied styles. (Doebler & Eicke, 1979, p. 226)

Since the early 1960s literally hundreds of research papers have looked at various aspects of field dependence. Field dependence is currently one of the most popular research topics in psychology. (Heesacker, 1981, p. 2)

Field dependence/independence has been studied extensively for over three decades (Witkin, Moore, Goodenough, and Cox, 1977). Of all the cognitive styles it is by far the most well-researched and has the greatest application potential to educational problems (Witkin et al., 1977 and Guilford, 1980). This is clearly no overnight product of some academic fad. (Rasinski, 1983, p. 1)

Two factors primarily account for extraordinary interest in the field-independence construct. First, theorists argue that field independence is value-neutral, and this feature of the construct may appeal to both researchers and practitioners. As Witkin, Moore, Goodenough and Cox (1977, p. 16) argue,

> This characteristic is of particular importance in distinguishing cognitive styles from intelligence and other ability dimensions. To have more of an ability is better than to have less of it. With cognitive styles, on the other hand, each pole has adaptive values under specified circumstances, and so may be judged positively in relation to those circumstances.

Similarly, Goodenough and Witkin (1977, p. 9) suggest that, "The field-dependence-independence dimension is bipolar; that is, it has no clear high or low end. As a consequence the dimension is value-neutral, in the sense that adaptive qualities are to be found at both poles." The value-neutral nature of the style may help explain why self-esteem is not significantly related to field-independence (Hullfish, 1978, p. 835).

The value-neutral nature of the field-independence cognitive style is one factor accounting for the tradition of interest in the style. A second important factor accounting for interest in the construct is that the style is apparently a cognitive manifestation of holistic personality variations.

Goodenough and Witkin (1977, p. 4) suggest that "Restructuring is in effect the expression of field independence in cognitive functioning." As Witkin, Moore, Goodenough and Cox (1977, p. 15) note,

> Cognitive styles are pervasive dimensions. They cut across the boundaries traditionally--and, we believe, inappropriately--used in

compartmentalizing the human psyche and so help restore the psyche to its proper status as a holistic entity.

Similarly, Fry and Charron (1980, p. 530) suggest that

> cognitive style cuts across domains of content, function, process, and value systems, and must therefore be differentiated from cognitive ability that delineates a basic dimension of performance underlying a fairly limited area of content.

The emphasis on a holistic variation in cognitive aspects of personality is in keeping with a recognition that global personality traits, such as neuroticism and dominance, have not tended to explain non-personality variables since global, non-cognitive aspects of personality may be less stable over different situations (Mischel, 1973).

Purposes of the Present Study

Witkin and his colleagues eventually discovered that the ability to perceive the upright was associated with the ability to disembed or locate figures hidden in a stimulus field. Thus, perceptual disembedding tasks have frequently been used in research "in place of the rather complex gadgets required for some of the early laboratory tests of field-dependence-independence" (Witkin, Moore, Goodenough & Cox, 1977, p. 7). Cox and Gall (1981, p. 5) cite 16 measures that have been employed with varying frequency to measure aspects of perceptual disembedding ability. Campbell and Donlon (1980) report initial development of a disembedding measure that was administered to

12,681 adults as part of a GRE administration.

However, the most frequently used measures have been the Preschool Embedded Figures Test (PEFT) (Coates, 1972), the Children's Embedded Figures Test (CEFT) (Witkin, Oltman, Raskin & Karp, 1971), and the Group Embedded Figures Test (Witkin, Oltman, Raskin & Karp, 1971). The Group Embedded Figures Test (GEFT) has been frequently used, in part because the measure has exceptional psychometric integrity even when evaluated by sophisticated measurement theory such as generalizability theory (Thompson & Melancon, in press), or when used with children (Thompson, Pitts & Gipe, 1983).

Although the GEFT has proven to be a very useful measure of aspects of field independence, the measure does have some limitations. The primary limitation is that the GEFT employs a "supply" format in which subjects actually draw on the target figure embedded within a stimulus. This means that tests are not reusable. Furthermore, as Donlon (1977, pp. 1-2) notes, "From the standpoint of a large-scale administration, however, the GEFT has the drawback of requiring trained personnel to score each item."

The present study reports the first phase of development of a multiple-choice perceptual disembedding measure, the Finding Embedded Figures Test (FEFT). However, in order to provide a backdrop for the report of initial development efforts, the paper also summarizes (a) literature establishing the practical importance of the field-independence construct, and (b) literature discussing the potential origins of varying degrees of field-independence in individuals. This review supplements the reviews available elsewhere (cf. Witkin & Goodenough, 1977, 1981;

Witkin, Moore, Goodenough & Cox, 1977).

Literature Review

Practical Importance of Field Independence

Numerous studies indicate the field-independence has noteworthy associations with myriad outcomes (cf. Goodenough, 1976; Witkin, Moore, Goodenough & Cox, 1977). The present review of the literature is intended to convey (a) the diversity of the variables associated with the construct, (b) the magnitudes of these relationships or effect sizes, and (c) the theoretical underpinnings of identified relationships.

The diversity f variables associated with field-independence is typified by studies indicating, for example, that field dependence is associated with obessity, at least in Caucasians (Pine, 1984). Apparently field dependence and alcoholism are related (Erwin & Hunter, 1984), though O'Leary, Calsyn and Fauria (1980) found that such conclusions may be artifacts of measuring the cognitive styles of alcoholics during continuing impairment from alcohol intake. Similarly, children classified as learning disabled have been found to be more field dependent than their normal peers (Guyer & Friedman, 1975), and learning disabled girls are apparently more field dependent than learning disabled boys (Ryckman, 1984).

Field independence has also been found to be related in theoretically predictable ways to social dynamics. For example, Sabatelli (1982, p. 16) used the individually-administered Embedded Figures Test (EFT) to study 48 couples and found that "husbands married to relatively field independent partners and

wives from dyads with large differences on cognitive style have fewer general global complaints about their relationships." Hoffman (1978) found that field independence was associated with the leadership behavior of groups of sixth-grade boys having both cognitive styles within their membership. Similarly, Kavanagh and Weissenberg (1973, p. 5) used the GEFT in a study involving 127 male undergraduate students and found that field-independent subjects employed more conceptually complex frameworks to interpret leadership behavior; this result was theoretically predictable:

> In terms of the perceptions/judgments of leader behavior, it may be simply easier to view C [Consideration] and IS [Initiating Structure] as end points of a bipolar continuum of leadership behavior where a decrease in one type of behavior would mean an increase in the other. It takes a more analytic and more difficult (in terms of processing information) approach (characteristic of the FI person) to deal with these two behavioral dimensions as independent. The results of this study reflect the more analytic approach of the FI individual as well as his capacity for greater categorization of his environment. (Kavanagh & Weissenberg, 1973, p. 5)

With respect to vocational choice, Witkin, Moore, Goodenough and Cox (1977, pp. 42-43) summarize the literature by suggesting that:

> The very large number of studies in which the relation between educational-vocational choices and cognitive style has been examined are, with only few exceptions, consistent in their outcome; and they strongly reinforce the finding from the studies of interests that relatively field-independent persons favor impersonal domains which require competence in cognitive articulation and field-dependent persons favor interpersonal domains which do not call for that kind of cognitive competence.

In an impressive longitudinal study, Witkin, Moore, Oltman, Goodenough, Friedman, Owen and Raskin (1977) found that undergraduate students who initially selected majors which were seemingly incongruous with their field-independence tended to change to majors in areas that were more compatible with their styles. Similarly, Thompson, Finkler and Walker (1979, p. 11) found that:

> The 2 x 6 ANOVA for GEFT scores yielded only a significant main effect for major ($F=4.50$, $df=5/97$, $p<.001$). Similar to Witkin's results, those in education ($M=8.0$, $n=21$) and social science ($M=10.25$, $n=13$) had the lowest GEFT scores while those in the natural sciences ($M=13.88$, $n=18$) had the highest GEFT score. [sic]

However, Campbell and Donlon (1980, p. 30) criticize the longitudinal study reported by Witkin, Moore, Oltman, Goodenough, Friedman, Owen and Raskin (1977) on the basis that Witkin and his

colleagues only studied students at one university. Campbell and Donlon (1980, p. 30) studied the relationship between field independence and choice of major in a national study with more than 12,000 students and found that their own measure of field independence "adds a negligible increment [to predictive power] when considered along with other predictors." But the researchers studied students taking the GRE and these subjects may have been more uniformly analytical by function of their interest in advanced training.

Some researchers have also found that field independence is positively related to creativity. Bloomberg (1967) reviewed relevant literature and suggested that field dependent persons are not flexible enough to utilize a level of cognitive functioning that will permit novel directions in thought and action. Thus, in a study of 112 undergraduates that employed a version of the Hidden Figures test, Noppe (1985, p. 94) found that "the constructs of field-dependence-independence and formal thought alone are reasonably effective predictors of creative ability." In a study in which the GEFT scores of 84 undergraduates were correlated with fluency scores on the Torrance test, Artley, Van Horn, Friedrich and Carroll (1980, p. 24) calculated the product-moment correlation between the measures to be 0.12. Similarly, Spotts and Mackler (1967, p. 53) correlated EFT scores of 138 male undergraduates with Torrance test scores, and found that the measures share roughly 5% of their variance in common. Thus, relationships are in the expected direction but are minimal in magnitude.

Research studies also consistently suggest that the more analytic abilities of field independent students result in better general academic achievement. This relationship is strongest in the elementary grades and deteriorates through the college level (Witkin, Moore, Goodenough & Cox, 1977). However, even at the college level,

> We have seen that field-dependence-independence does not show much relation to overall achievement measures, such as college grade-point average. In contrast, numerous studies have demonstrated a relation between cognitive style and performance in specialized areas. (Witkin, Moore, Goodenough & Cox, 1977, p. 45)

More field independent students enjoy an achievement advantage because of their abilities to (a) provide structure for ambiguous stimuli, (b) break organized fields of stimuli into basic elements, and (c) provide different organizational structures to stimuli than those that are inherent in a stimulus complex (Witkin & Goodenough, 1981).

Several studies can be cited as exemplars of investigations involving relationships between field independence and various general measures of achievement. For example, Wicker (1980, p. 5) administered the Children's Embedded Figures Test to 248 youngsters and found that "Very few FD students gain conservation in the first grade while most FI students are transitional or are conserving. By third grade, there were no FI conservers and no FD conservers." In a study in which Hidden Figures Test scores of 187 Filipino high school girls were correlated with grade point

averages, Watkins and Astilla (1980, p. 593) found that:

> The data support the proposition that field independence shares a small but significant amount of variance [8%] of school achievement [measured by GPA] after the variance attributable to intelligence is removed.

In a study in which the GEFT scores of 22 adult CETA GED students were correlated with GED scores, Donnarumma, Cox and Beder (1980, p. 228) reported that,

> Using raw scores a significant positive correlation was also found between GEFT scores and total GED scores (r = 0.36 [r sq about 10%], $p < 0.01$)... The Pearson correlation coefficients between GEFT and GED reading, GED math, and GED English usage were approximately equal.

In an analysis based on data from 40 adult subjects, the researchers "also found that more of those who dropped out of GED instruction were field dependent than those who persisted" (Donnarumma, Cox & Beder, 1980, p. 230).

Field independence has also been found to be related to problem-solving and concept-learning skills in theoretically expected ways. For example, Shapson (1976, p. 17) studied the problem-solving skills of 3rd graders and found that:

> As a function of FDI, children differed in their ability to utilize all aspects of the stimulus situation with equal effectiveness. While FD children tended to overrespond to one dimension,

> no one specific dimension was prefered by this group of children. For example, one FD subject showed a response bias to the colour dimension, another to position and a third to letter. Nevertheless on any trial, FD children were only processing part of the available information.

Similarly, Rains and Meinke (1976, p. 8) administered a Hidden Figures Test to 64 subjects and found that:

> The main effect of cognitive style was significant, and consistent with the results reported by other researchers (Davis, 1967; 1972; Fredrick, 1968; Nelson, 1972; Nelson and Chavis, 1975). F-I students demonstrated performance superior to F-D students on all three [concept learning] dependent variables.

Ronning, McCurdy and Ballinger (1984, p. 71) related GEFT scores and science problem-solving scores of 150 junior high students and found that:

> Field independent students significantly outperformed field dependent students on the problems. [Qualitative] examination of protocols revealed consistent performance patterns favoring field independent students.

Stasz, Shavelson, Cox and Moore (1976) studied concept learning in a social studies minicourse and found that more field-independent subjects displayed greater differentiation of social studies concepts and their concept structures more closely matched those of the subject matter.

Field independence also apparently predicts achievement in a number of diverse specific achievement areas. For example, Suddick, Yancey, Devine and Wilson (1982, p. 227) related clinical grades in a dentistry program and the EFT scores of 110 dental students and found "that individuals who tend to be field-independent, rather than field-dependent, may have an advantage in the dental school's curriculum." Copeland (1983, p. 157) related grades in an art appreciation course with GEFT scores of 129 students and reported that, "The findings supported the hypothesis that students with higher GEFT scores would receive higher course grades and students with lower GEFT scores would receive lower course grades." Schmidt (1984, p. 166) correlated GEFT scores of 75 music learning theory students and reported that:

> The obtained Pearson correlation coefficient of 0.30 and explained variance in the regression analysis indicate a rather modest relationship between the GEFT and aural skills achievement... With approximately 8% of the variance in aural skills achievement accounted for, the relationship may suggest practical significance.

Elliott and McMichael (1963) and Meek and Skubie (1971) found that more field-independent persons tend to have more atheletic interests and skills; the finding is logical since atheletic activities often require greater focus on internal body sensations and segregation.

Field independence has also been found to be related to

achievement in academic areas involving graphics or spatial abilities in theoretically expected ways. For example, Wilson and Davis (1985, p. 69) found that the GEFT scores of 21 engineering graphics students shared 43% of their variance with course grades; interestingly, a version of the Hidden Figures Test only shared 24% of common variance with course grades. In a study of map location skills of 64 high school and 68 undergraduate students, Shaha (1982, pp. 9-10) administered the Hidden Figures Test and found that "Field-independent subjects were better able than field-dependent students to remember spatial information and accurately place map features that they recalled during the reconstruction task." In a similar study of 34 gunnery students, Letchworth, Ragan, Stansell and Huckaby (1978, p. 26) administered the GEFT and found that "Field dependent individuals seem to have more difficulty in the tasks of target and self location than do field independent individuals." The standardized effect size advantage favoring more field-independent subjects was about 1/2 SD on both target location and self location tasks. In a study relating GEFT scores with both drafting course grades and standardized drafting test scores of 167 high school students, Guster (1986, p. 33) found that GEFT scores shared about 10% of variance in common with standardized test scores and about 15% of variance in common with course grades.

Cognitive style relationships with basic skills achievement in both mathematics and discourse processing have been of particular interest to researchers, since these areas are basic to other areas of learning. The findings of Blaha (1982, p. 113) are fairly representative. In a study of achievement of 324 inner

city 5th graders in relation to basic skills achievement, he reported that "the children who were field-dependent, possessing a relatively global cognitive style wherein their perceptions tended to be determined by their organization of the field, tended to achieve lower scores in reading and arithmetic."

With respect to mathematics achievement, Vaidya and Chansky (1980) found that more field-independent elementary school students tended to have higher math achievement scores. Roberge and Flexer (1983, p. 344) reported that,

> In the past decade, educational researchers and psychologists have shown considerable interest in the relationship between cognitive style and the mathematics achievement of elementary school children (Buriel, 1978; Kagan & Zahn, 1975; Kagan, Zahn, & Gealy, 1977; Robinson & Gray, 1974; Satterly, 1976; Vaidya & Chansky, 1980). The dimension of cognitive style that has received the most attention in this regard is field dependence-independence.

The researchers related GEFT scores of 450 junior high school students and found that the mathematics achievement scores of the field-independent students were "significantly higher" (p. 344).

Numerous studies have been conducted to investigate relationships between field independence and discourse skills. As Rasinski (1983, p. 4) notes, "one of the first overarching and consistent findings in this line of research has been that good readers tend to score higher on measures of field independence

than poor readers." For example, Williams (1985, p. 485) related GEFT scores and scores for writing coherency involving 44 undergraduates and reported that:

> The correlation between cognitive style and mean coherence scores was significant, $r(32) = 0.54$, $p < 0.002$, as was the correlation between cognitive style and abstracting ability, $r(32) = 0.90$, $p < 0.0001$. The correlation between IQ and coherence, however, was insignificant, $r(32) = 0.26$, $p < 0.15$, as was the correlation between IQ and cognitive style, $r(32) = 0.2^{\wedge}$, $p < 0.28$.

Blaha and Chomin (1982, p. 31) related GEFT scores to 322 inner-city 5th-graders' perceptions of difficulty with reading and found that field dependent children "tended to perceive themselves as having difficulty with reading and were willing to acknowledge the existence of a problem;" the two variables had about 5% of variance in common. Blake (1985) related the EFT scores of 121 6th graders with text comprehension scores and reported standardized effect sizes across low, moderate and high field independence of almost one SD between each group, with more field-independent subjects enjoying the achievement advantage.

Various studies suggest that these influences cut across diverse discourse phenomena. For example, Scott, Annesley, Maher and Christiansen (1980, p. 13) studied the reading miscues of 16 Australian 8th graders who completed the GEFT and found that:

> Field dependent below average readers used less proficient reading strategies compared with field independent below average readers... Field

dependent above average readers used less proficient reading strategies compared with field independent above average readers.

Similarly, Hansen (1984, p. 311) related GEFT and cloze performance scores of 286 11th graders and found that, "When the sample was taken as a whole, a significant relationship [squared r = 18%] was found between field dependence/independence and cloze scores." In another study, Stansfield and Hansen (1983, pp. 29, 37) related GEFT and cloze test scores in a second language from 250 undergraduates and reported that "The results showed student FI to be related consistently in a positive albiet modest fashion to second language test performance. The relationship was less marked on other measures such as final course grade (r = 0.43, $p < 0.001$)."

Several theoretical explanations for these performance differences have been noted by researchers. First, the analytical interests and abilities of FIs may provide an advantage in discourse processing. For example, Davis and Frank (1979) found that field-independents tend to perform better on recall tasks involving word lists with more difficult organizational structures. Noble and Frank (1985) were unable to replicate this finding in an anagram study, but acknowledged using far fewer anagram tasks than have been used in most studies. Annis (1979, p. 620) related GEFT and text recall scores of 129 undergraduate students and found that more analytical FIs were better able to focus on the critical text content:

Results indicated that field-independent students

> scored better than field-dependent students on completion items of high structural importance to the meaning of the entire learning passage. However, the effect of cognitive style on material of low structural importance was not significant.

Similarly, Threadgill-Soweder, Sowder, Moyer and Moyer (1985, p. 62) administered their own version of a Hidden Figures Test and found that:

> Overall, story problems offered via a drawing that served to organize the data in the problem were most helpful to students scoring low on cognitive ability tests and were not detrimental to those students scoring high on these tests.

A second though related advantage favoring more field independents may stem from the imagery and restructuring abilities of FIs. For example, Carrier, Joseph, Krey and LaCroix (1983, p. 158) collected GEFT data from 95 6th graders and found that:

> Field independent children showed a much higher mean in the imagery instructions, before condition than did field dependent children in the same condition or field independent children in the imagery instructions, after condition. This suggests a greater capacity to capitalize on an elaboration strategy in the instructional process.

Similarly, Pierce (1980, p. 200) collected CEFT data from 143 primary grade students and found that:

> The relation between imagery-assisted prose recall

> and field independence was found to be significantly stronger than the relation between control recall and field independence for third graders, but not for kindergartners... It is possible that children who learn more readily from imagery directions have relatively field-independent cognitive styles, such that they can readily perceive part-whole relations. The ability to organize the parts of a picture into a whole would seem to be vital if children's memory for prose is to benefit from imagery directions.

In the third grade the standardized effect size favoring the FIs was about one SD.

Third, field-independent students may enjoy a processing advantage as a function of the conceptual schema that they bring to discourse processing situations. As Spiro and Tirre (1979, p. 10) suggest,

> Successful performance on an embedded figures test requires a freedom from Gestaltbindung (Thurstone, 1941), an ability to overcome the perceptual resolution of a stimulus configuration in order to detect the presence of a target structure retained in memory. Somewhat analogously, successful discourse processing requires that an individual not rely exclusively on the "stimulus configuration" of that situation, i.e., the explicit structure and content of the text as

presented.

The researchers collected data from 112 undergraduates and found that:

> The hypothesis was confirmed in striking fashion. Low and high EFT scorers (with verbal ability statistically removed) recalled food items equally well from the supermarket passage, for which the underlying "foods purchased" schema component is not highly constrained. However, for the parallel restaurant passage, with its finely articulated "foods purchased" scema component, food item recall increased radically compared to the supermarket passage only for the higher EFT scorers. (Spiro & Tirre, 1979, p. 10)

Pitts and Thompson (1984) report similar results in a study using a different design.

Research suggests that individual differences in cognitive styles are also manifested in differential instructional response. As Guster (1986, p. 25) notes,

> Research in the area of cognitive style related to instructional environment has demonstrated that variations in perception exist among students and that these variations involve adaptive characteristics that may result in performance differences, depending upon the instructional mode of the learning environment.

These effects are theoretically predictable. For example, Oltman, Goodenough, Witkin, Freedman and Friedman (1975) suggested that

more field-dependent subjects, who tend to be more social, may tend to get along better with teachers. Witkin, Moore, Goodenough and Cox (1977, p. 2) suggest that field-independence can affect "how students learn; how teachers teach; how teachers and students interact."

For example, Jacobs and Gedeon (1982, p. 24) collected GEFT data from 53 male undergraduate technology students and found that, "Among [theoretically more social] field dependent students, there was a significantly greater tendency to obtain specific course information through social contacts initiated with proctors." The standardized effect size for the more field-dependent students to solicit specific information in contacts with instructors was about 1.2 SDs. In another study Daniel, Rasmussen, Jackson and Brenner (1984, p. i) gathered GEFT scores from teachers in 10 sections of speech involving 141 undergraduate students and found that:

> Field Dependent teachers recieved the highest evaluations from Field Dependent students while Field Independent teachers recieved the lowest ratings from them. Generally, Field Dependent teachers were evaluated higher by all students and Field Independent teachers were evaluated least favorably.

Cognitive style impacts on instruction involve various dynamics. For example, Avolio, Alexander, Barrett and Sterns (1981) found that field independence affects attention--more field-independent students are able to perform better in the

presence of competing auditory or visual stimuli. As another example, Annis and Davis (1978) found that more field independent subjects achieve better than more field dependent peers except when FIs are required both to use less preferred study methods and no review.

Field independence also is predictive of responses to instructional method. For example, Douglass (1978, p 6) investigated the biology achievement of 627 high school students in relation to GEFT scores and found that:

> When the effect of general intelligence was removed by ANCOVA, neither the main effect of cognitive style nor instructional sequence had a significant effect upon the level of achievement of the students. However, cognitive style and instructional sequence interacted [$p < 0.10$] in such a way that the FI subjects experienced a higher level of achievement with IND [inductive] materials and the FD subjects experienced a higher level of success with DED [deductive] materials.

Extreme groups comparisons resulted in more dramatic effects. McLeod and Adams (1979, p. 32) administered a modified Hidden Figures Test to 46 prospective elementary teachers and found that "The interaction supported the hypothesis that field-independent students achieve most in a discovery treatment, and field-dependent students learn best in expository instruction."

Field independence also affects reaction to instructional reinforcement. As Witkin and Moore (1974, pp. 8-9) summarize this literature,

> The weight of the evidence from these studies suggests that this kind of reinforcement has little effect on the learning of relatively field-independent students. On the other hand, it has a decisive effect on the learning of field-dependent students. More specifically, for field dependents, general disapproval has a negative effect while general approval seems to have no influence.

For example, Bolocofsky (1980, p. 213) administered the GEFT to 210 10th graders and reported that:

> A significant interaction between field dependence and competitive motivation was found: field dependent subjects increased their performance significantly when competing, while field independent subjects exhibited only a slight and nonsignificant change.

Numerous studies have considered the effects of <u>style matching</u> in counselor-client and other helper-helpee relationships. The theoretical basis for examining matching dynamics involves recognition that matching on field independence may improve relationships and effectiveness by producing common personality characteristics, shared interests, and similar modes of communication (Witkin, Moore, Goodenough & Cox, 1977). With respect to communication, for example, Frank and Davis (1982, p. 28) examined communication among groups of 128 female undergraduate students who completed both the GEFT and a Hidden Figures Test and found that:

> Field-independent individuals are better than field-dependent individuals both as transmitters and as receivers. Thus, when they are matched they do better than when they are mismatched. The field-dependent individuals, however, do less well when they are matched than when they are mismatched.

However, the theoretical underpinnings underlying research on style matches are complex (Miller, 1981). As Witkin, Moore, Goodenough and Cox (1977, p. 36) note regarding instructional situations, "As one example, it may be that for some kinds of learning content a contrast in styles between teacher and student may be more stimulating than similarity."

Some research suggests that style matching in clinical dyads may affect interactions and outcomes. For example, Witkin, Lewis and Weil (1968) found that therapists, regardless of their cognitive styles, took significantly more directive roles with their more field-dependent clients. Folman (1973) found that matching clients and counselors resulted in more desirable therapeutic dynamics. Similarly, Fry and Charron (1980, p. 536) studied 32 pairs of counselors and clients matched or mismatched based on GEFT results and reported that:

> The findings suggest that clients' subjective evaluations of their improvements in self-exploration skills and their perceptions of the ease of relating and learning from their counselor-partners may benefit considerably from the technique of cognitive style matching.

However, the intervention was brief and involved self-exploration rather than voluntary help-seeking regarding deep seated problems or trauma.

Even more research has been done regarding matching in instructional settings. For example, Saracho (1980, p. 40) collected CEFT data from 432 children and GEFT data from 36 teachers and investigated discrepancies between teachers' perceptions of student achievement and actual student achievement:

> Both field-dependent and field-independent teachers ranked match students similarly to their ranking on the standardized achievement test scores. However, field-dependent teachers tended to have greater discrepancy scores, and negative ones, when ranking mismatched children.

As a theoretical basis for their findings the researchers suggested that "It is possible that field-dependent teachers may have difficulty assessing field-independent students since these students tend to isolate themselves and conceal outward behavior" (p. 47).

Research results suggest that students and teachers matched on field independence may view each other more positively (DiStefano, 1970). Students may report greater ease of interaction and learn more when matching is employed, although matching may have greater effects for more field dependent students, since they are more sensitive to external and social influences (Packer & Bain, 1978). Paradise and Block (1984, p.

59) collected EFT data from 20 teachers and 200 4th graders and found that, "The results provide support for the contention that matching students and their teachers on the field dependence/independence dimension of cognitive style can affect student's academic achievement." Similarly, MacDonald (1984, p. 725) gathered GEFT scores from 10 instructors and 386 community college students and found that:

> The correlational analysis supported the belief that student's course grades and GPA were very slightly greater when there was similarity rather than dissimilarity of personality type with that of their instructor.

However, Mahlios (1982, p. 68) collected GEFT data from 82 dyads of teachers and student teachers and found that:

> There was a pattern within groups favoring students not matched on cognitive style. In the areas of adaptability to change and communication skills, student teachers in disparate dyads achieved better than their counterparts in compatible dyads. In both instances field-dependent students placed with field-independent teachers achieved higher than the other three groups.

Jolly and Strawitz (1984, p. 490) collected GEFT data from 10 teachers with 545 students and found that "FI students may be taught by and achieve equally well with either FI or FD teachers, FD students are more successfully taught by FI teachers;" the finding seems to be theoretically predictable given the greater

self-versus-other segregation of more field-independent persons and their previously noted achievement advantages, at least in lower grade levels. However, the findings of Doebler and Eicke (1979, p. 231), based on EFT data collected from 170 subjects, are noteworthy: "the improved interpersonal relationship between teachers and students found... [by others] can be obtained without matching, but simply by making teachers aware of the educational implications of cognitive style."

Renninger and Snyder (1983, pp. 673-674) collected GEFT scores from eight teachers and 192 high school students and suggested the following source of variance which may account for these various findings:

> Our results indicate (a) higher scores on standardized scholastic ability tests among field-independent as compared to field-dependent students, (b) the expected interaction effect of student and teacher cognitive style on students' perception of satisfaction and a parallel trend on their perception of teacher effectiveness... Subsequent analysis of simple main effects, however, locates the source of the interaction largely in the differential reactions of field-dependent students to teachers of differing styles.

Mahlios (1981, p. 154) collected GEFT data from 12 teachers and 48 5th and 6th graders and suggested that the teachers' style may affect interaction more than the match of styles. Similarly,

Saracho and Dayton (1980, p. 544) gathered GEFT scores from 36 teachers and CEFT scores from 432 children, and found that:

> The results indicated significant effects on gains due to teachers' cognitive styles, but there was no significant outcome (main or interaction effect) associated with the matching variable or with grade level. Thus, children with field-independent teachers showed greater achievement gains than children with field-dependent teachers.

Potential Origins of Field-Independence Variations

Field independence, as measured by perceptual disembedding or restructuring tasks, and in particular by the Group Embedded Figures Test, has been found to have noteworthy relationships with diverse outcomes. These findings have stimulated inquiry regarding the origins of cognitive style variations. Evidence supporting the influence of both environmental and biological origins of style differences has been adduced by researchers. Biological origins will be considered first.

Some research suggests that hormones may influence performance on measures of field independence. For example, Money and Alexander (1966) and Shaffer (1962) found that Turner women, who are deficient in sex hormones during development, but of normal verbal intelligence, are relatively field dependent on measures of spatial visualization and disembedding. Similarly, Dawson (1966) studied Kwashiorkor cases, who have low androgen/estrogen ratios during development, and found that these subjects perform less well on spatial visualization tests.

Research also indicates that genetics may affect field independence. Bock and Kolakowski (1973) and Hartlage (1970) reasoned that since fathers contribute their only X chromosome to their daughters, while sons receive their only X chromosomes from their mothers, if field independence is an X-linked trait there should be higher correlations between spatial ability scores of members of opposite-sex parent-child pairs and negligible correlations between fathers and sons; their results were supportive of this expectation. Yen (1974) reasoned that since sisters share the only X chromosome their father has to give, but brothers receive one of either of the two Xs mothers have to give, there should be higher correlations in spatial visualization scores between sisters than between brothers; results supported this expectation. However, it is not certain that the spatial visualization abilities explored in these studies are exactly the same as the abilities employed in perceptual disembedding tests such as the GEFT.

Goodenough, Gandini, Olkin, Pizzamiglio, Thayer and Witkin (1977) conducted a study of gene "markers" involving known trait-transfer sites and found that both EFT and RFT ability may be influenced by an X chromosome site located near the locus for the Xg blood groups. This study had some possibly important theoretical implications, as Goodenough and Witkin (1977, p. 19) explain:

> It is noteworthy that no evidence of linkage with the Xg marker for tests of spatial-visualization ability was found in the Goodenough et al. [1977] study. This suggests that if an X-chromosome gene

contributes to EFT and RFT performance, it is not the same one that contributes to spatial-visualization ability.

Some researchers have noted that sex differences in field independence might be related to biological influences (Waber, 1977), but these differences may also be associated with sociological environmental influences. Supporting the second interpretation, Berry (1966) notes that sex differences are more pronounced in cultures that emphasize sex differences. Research suggests that young girls may perform better on restructuring measures than their male peers (Coates, 1974). At the elementary school level, males tend to be somewhat more field independent than same-aged females (Clack, 1970; Eddy, 1974; Finley & Solla, 1975; Stanes & Gordon, 1973).

Goodenough and Witkin (1977, p. 15) note that "The fact that boys' superiority over girls' in spatial-visualization ability (and perhaps disembedding ability) becomes prominent only during adolescence also fits well with the idea that these abilities may show an arrest in development with pubertal onset." Although adult males tend to do better on cognitive restructuring tasks (Maccoby & Jacklin, 1974; Witkin, Dyk, Faterson, Goodenough & Karp, 1962/1974), statistically significant differences tend to occur with larger sample sizes (Dickie, 1970; Nedd & Gruenfeld, 1976; Renzi, 1974).

Some studies indicate that masculine body type is associated with being more field-independent (Klaiber, Broverman & Kobayashi, 1967; Murawski & Jones, 1970; Peterson, 1976;

Rosenberg, 1976). However, Hulfish (1978, p. 835) collected GEFT data from 100 subjects and found that, "regardless of biological sex, subjects with relatively masculine role-identities are more field-independent than subjects with relatively feminine role-identities."

Although research evidence supports a conclusion that biological factors to some degree influence the development of field independence, a good deal of evidence supports a conclusion that cognitive style also has environmental origins. Research regarding cross-cultural variations in style orientations (Witkin & Berry, 1975) can be interpreted to support conclusions that either environment or biology determine cognitive style, since cross-cultural variations involve both sociological environmental differences and some inbreeding within gene pools. However, given cross-cultural mobility, this evidence may generally support a conclusion that field independence has origins in environmental differences. Evidence that different cultures that emphasize similar values often include a preponderance of a given style supports this interpretation.

For example, Hansen (1984, p. 311) administered the GEFT to 286 11th graders and found "Hawaiian students... to be significantly more field independent than Samoan, Tongan, Fijiian, Indian-Fijiian, and Tahitian students." Pine (1984, p. 205) collected GEFT data from 160 subjects and found that "American Indians were more field-dependent than Caucasians overall, which implies a social conformity factor" in cross-cultural variations in field independence. As Goodenough and Witkin (1977, p. 37) summarize this evidence:

> In overview, the expectation that members of cultures and subcultures which are tight in their social organization and stress social conformity would be more field dependent than members of cultures and subcultures which have a loose social organization and place less stress on conformity has received substantial support.

Studies involving sensory deprivation effects also support the view that field independence has its origins at least partly in environmental influences. For example, Witkin, Birnbaum, Lomonaco, Lehr and Herman (1968) found that congenitally blind subjects tended to be field dependent. Parasnis and Long (1978, p. 1) administered the GEFT and reported that:

> The hypotheses that deaf students would be more field dependent than hearing students and that their competence in communication skills would be related to field dependence were supported for a group of 77 male and 67 female deaf students.

Also with respect to impacts of environment on field independence, several researchers have investigated the degree to which field independence can originate in training interventions. Various researchers (e.g., Goldstein & Chance, 1965; Klepper, 1969; Szeto, 1976; Wilkie, 1973) have found that even relatively brief training may improve performance on specific style measures. However, as Goodenough and Witkin (1977, pp. 21-22) note,

> While these various training procedures affect

> test performance itself, it is doubtful that they alter the underlying perceptual functions of concern to us (Witkin, Note 9). Extensive instructional efforts which result in transfer of training to other test materials than those used in the training clearly have more important implications for both theory and educational applications.

Gill, Herdtner and Lough (1968) report that atheletic training may improve performance on the rod-and-frame test; this finding is theoretically sensible since atheletics require segregation from the external environment and should therefore be associated with greater field independence. Hurwitz, Wolff, Bortnick and Kokas (1975) found that specialized music training of 1st graders for 40 minutes daily for seven months resulted in improved performance on the CEFT; again, the finding is theoretically sensible since music performance requires segregation and perhaps analytic ability as well. Similarly, Britain, Dunkel and Coull (1979, p. 10) provided eight 15-minute training sessions in visual scanning strategies and found that:

> These data appear to indicate that training had no significant effect on overall CEFT performance. However, FI children performed significantly better on both the PEFT and CEFT. Trained FD children tended to perform better than Control FDs, but trained FI children tended to perform slightly worse than Control FI. Hence, as expected, training, to some degree, appeared to

facilitate FD children more than FI.

Thus, since intervention may affect both specific performance and generalization, intervention studies suggest that field independence is to some degree environmentally determined.

Researchers have also investigated possible developmental origins of the cognitive style. It has been established that individual differences in field independence are manifested even by preschool children (Coates, 1975; Coates, Lord, & Jakobovics, 1975). With respect to perception of the upright, both longitudinal and cross-sectional research (Witkin, Dyk, Faterson, Goodenough & Karp, 1962/1974; Witkin, Lewis, Hertzman, Machover, Meissner & Wapner, 1954/1972) indicates that children become increasingly field independent until their midteens, and remain relatively stable into late adulthood. However, there is also a tendency for children to remain interindividually stable in field independence when comparisons are made with like-aged peers thoughout developmental changes.

Researchers have noted the tendency to become more field independent between kindergarten and 1st grade (Cecchini & Pizzamiglio, 1975; Massari, 1975). Treadgill-Sowder, Sowder, Moyer and Moyer (1985, p. 58) report a cross-sectional study of roughly 150 children in each of the grades, three to seven, and found a standardized effect size change of about one-half a SD of improvement between grades three and four, and therefter increased field independence changes of about one-quarter SD; subjects also tended to become more heterogenous with respect to style as they aged. Witkin, Goodenough and Karp (1967) studied

eight to 13 year olds and 17 to 24 year olds longitudinally and found that subjects tend to become increasingly field independent until roughly age 17. Lee and Pollack (1973, p. 16) administered the EFT 12 to females from each decade of life, the 20s to the 70s inclusive, and found that:

> The large discrepancy found between the quantitative performance scores of the 40s age group and those of the 50s shows that a marked decline occurs during middle age, vis-a-vis old age. This has important implications as far as what type of performance should be expected of those in their 50s. Furthermore, it could be suggestive of what factors might be causing the decline, e.g., hormonal changes within the individual.

Substantial effort has been devoted to exploring the environmental influences of the family on the development of field independence. For example, Witkin, Price-Williams, Bertini, Christiansen, Oltman, Ramirez and van Meel (1974) suggested that nuclear as against extended families social structures tend to result in more field independence in children. Dawson (1967a, 1967b) found that polygamous African families with more wives tended to produce sons who are more field dependent. Girls who identify less with their mothers tend to be more field independent (Constantinople, 1974; Nilsson, Almgren, Kohler & Kohler, 1973).

Several researchers have suggested that parental behaviors rather than parental attitudes are what impact cognitive styles

of children (Claeys & DeBoeck, 1976; Lee, 1974; Ramirez & Price-Williams, 1974; Tendler, 1976). The power structure and role delineation within the family also appears to be important. For example, Dreyer (1975, pp. 11-12) collected CEFT data from 38 kindergarten children, conducted actual observations of families, and reported that:

> A more sharply defined set of family roles and more stability in this power structure seems to characterize the families with FD children. Along with the changing power structure of the FI families was the emergence of the same sex parent as the strong, intrusive figure in the behavioral characteristics that were observed.

Several researchers have investigated the impacts of specific family members. For example, Lee (1974) and Trent (1974) found that the absence of fathers tends to be associated with more field dependence in children. Dershowitz (1971) found that children of weaker or more inattentive fathers are more likely to be field dependent.

More research has been conducted to investigate the influence of cognitive styles of mothers. For example, Dyk (1969) conducted a longitudinal study and found style differences to be associated with the comforting strategies used by mothers; mothers who give comfort in ways more specific to the problems of their children tend to have more field independent children. Dyk and Witkin (1965) reported that mothers of field-dependent sons were more likely to restrict the community activities of their

children, placed more emphasis on conformity, were more discouraging of assertive behavior, and were less likely to stimulate assumption of responsibility.

Moskowitz, Dreyer and Kronsberg (1981, p. 607) collected PEFT from 24 children and reported that:

> The children's exploratory behaviors and the mothers' behaviors at infancy and preschool were not predictive of cognitive style. The children's social behaviors at both ages were highly related to their cognitive styles. Examination of the regression equations suggested that field-dependent children seek more emotional reassurance from their mothers at both times of observation than field-independent children. The data did not provide support for the idea that mothers' proximal and distal behaviors towards their children influenced the early development of field independence.

Similarly, Laosa (1978, p. 28) collected EFT data from mothers and CEFT data from 43 Chicano children and found that:

> Relatively field-independent mothers were observed to use inquiry and praise as teaching strategies more frequently than did relatively field-dependent mothers. On the other hand, relatively field-dependent mothers more frequently taught through modeling.

Lao (1978, p. 28) concluded that:

> the use of praise, in the context of the tasks

used here, is likely to encourage the child to approach problem-solving by "acting on the field." In contrast, teaching through modeling requires that the learner adhere to the field as given and rely on others as sources of information. Hence, the results support the hypothesis that each mother teaches her young child using the type of strategy that is likely to stimulate in the child the development of a cognitive style similar to her own style.

With respect to research regarding both the biological and the environmental origins of field independence, Goodenough and Witkin (1977, p. 20) note that

> it seems likely that some portion of the variance among people in spatial-visualization ability is attributable to an X-linked genetic determinant, perhaps mediated by hormonal factors... [But] with the very limited evidence on hand, a definitive statement about the possible origins of field dependence-independence in the biological development of the individual--hormonal and genetic--is clearly not yet possible.

Environmental influences are clearly a noteworthy source of variations in field independence.

Development of the Finding Embedded Figures Test

The Finding Embedded Figures Test (FEFT) (Thompson & Melancon, 1987) was developed to provide a multiple-choice,

machine-scoreable measure of perceptual disembedding or restructuring as an alternative to supply-format tests such as the GEFT. A multiple-choice test avoids difficulties associated with supply-format requirements for use of scorers and with concerns about interrater reliability. The FEFT was also developed in the expectation that the use of another measure might shed additional light on the nature of the field-independence construct. As Linn and Kyllonen (1980, p. 1) note,

> Interest in the field dependence/independence (FDI) construct is currently widespread. In the past 10 years there has been a proliferation of research in this area... In spite of widespread interest, the construct represented by the various measures of FDI is not well understood.

Instrument Development

Test reliability is a function of the ratio of systematic score variance to total score variance. Since persons can "spread out" more on tests with more items, and since increments in score variance usually consist of more systematic variance than error variance, longer tests often are more reliable than shorter tests. However, selection-format tests, such as multiple-choice tests, are not really as "long" as the number of test items.

Selection-format tests actually have a "floor" that is a function of the number of choices per item. The "floor" of the test is the score that would be most likely if a test-taker guessed the response to each item. For example, on a 100-item true-false test, the "floor" would be 50.00 (100 / 2). On a 100-

item four-choice test, the "floor" would be 25.00 (100 / 4).

The true length of the test is the number of selection items minus the floor. For example, a 100-item true-false test has a length of 50.00 (100 - 50.00). Berenson, Thompson, Nicklas, Harsha, Johnson and Webber (1987) illustrate the calculation of test lengths for tests consisting of selection items with varying numbers of choices for different items.

A five-choice item response format was selected for use on the Finding Embedded Figures Test (FEFT) in order to maximize true test length. An initial item pool of 110 items was developed. Each item presents a target figure which is located in only one of the five response alternatives. As used in the present study, subjects respond to each item by indicating the letter code for the response alternatives containing the target.

It was not considered feasible to administer all 110 items to all subjects in our initial studies of the measurement characteristics of the FEFT. Therefore, we developed four test forms for use in the present study. We conducted a small pilot study with a dozen undergraduate students who completed all 110 FEFT items, and we selected the 10 items with the largest item-total correlation coefficients as "linking" items used on all four test forms. Twenty-five of the remaining 100 items were employed on each of the four forms. Thus, each test form consisted of 35 items.

Subjects

The subjects were 72 students enrolled in the range of undergraduate mathematics courses offered during a summer term.

The breakdown of the subjects across student classifations was: freshman, 16 (22.2%); sophomore, 12 (16.7%); junior, 10 (13.9%), senior, 26 (36.1%); graduate, 8 (11.1%). Forty-three (59.7%) of the subjects were females. The mean age of the subjects was 21.8 (SD = 4.7).

Analysis

Subjects were randomly assigned one of the four FEFT forms used in the present study, and each subject also completed the GEFT. Tables 1 through 4 present item analysis results for each of the four forms.

INSERT TABLES 1 THROUGH 4 HERE.

The tables present the proportion of subjects selecting each response alternative for each item. Correct choices are designated by asterisks; the attractiveness of the correct choice is represented in the item difficulty statistics, the proportion of subjects who correctly answered the item. The tables present the standard deviation associated with each item difficulty statistic.

As Thompson and Levitov (1985, pp. 164-165) note,

> items tend to improve test reliability when the percentage of students who correctly answer the item is halfway between the percentage expected to correctly answer if pure guessing governed responses and the percentage (100%) who would correctly answer if everyone knew the answer. For example, on a four-alternative multiple-choice

item, if everyone responded purely on the basis of guessing, theoretically 25% of the students would correctly answer the item on the basis of chance alone. The value halfway between this percentage and 100% would be 62.5%.

Remaining responses should be fairly evenly distributed among incorrect responses.

The tables also report the item-to-total score correlation coefficients, i.e., coefficients between item scores ("0" or "1") and total test scores ("1" to "35"). These coefficients are reported as "internal validity" coefficients. Larger and more positive values are desirable.

The tables report "external validity" correlation coefficients, i.e., coefficients between total FEFT item scores ("0" or "1") and total GEFT scores ("0" to "18"). Finally, the tables report "total validity" coefficients, i.e., coefficients between FEFT item scores and scores on the combination of the FEFT and the GEFT measures ("0" to "53"). Since the last coefficients involve the most information, they were considered to be especially important in making decisions about item quality. Thus, the items in the tables have been sorted by the magnitudes of these "total validity" coefficients.

Table 5 summarizes the item analysis results for the 10 linking items also presented in Tables 1 through 4. Table 5 also presents item difficulty and validity coefficients for each linking item based on data from all 72 subjects. Table 6 reports total test statistics for each of the four forms and for all 72

subjects. The results presented in Tables 5 and 6 suggest that the each of the four samples of subjects were reasonably representative of each other and that generalizations can be drawn from pooling of results across the samples.

INSERT TABLES 5 AND 6 ABOUT HERE.

Table 7 presents alpha reliability coefficients for the GEFT, the combination of the GEFT and the FEFT, and for the FEFT alone. These results are also presented separately for each form and for the linking data involving all 72 subjects.

INSERT TABLE 7 ABOUT HERE.

Discussion

The importance of the field-independence cognitive style has been amply demonstrated in previous research. The present study was conducted to develop multiple-choice, machine-scoreable alternatives to the use of the Group Embedded Figures Test (GEFT). Data from 72 subjects were collected to determine which items from a pool of 110 items should be retained in the next generation of the Finding Embedded Figures Test (FEFT).

The results presented in Tables 1 through 7 suggest that some items from the pool had expected measurement integrity. As expected, other items were too easy, too hard, or did not elicit stable response patterns. Based on the results in the present study, two forms ("A" and "B") of the FEFT were developed. Items were selected from the pool based on consultation of the tabled results. Particular attention was given to the "total validity"

coefficients, since the total scores produced by combining FEFT and GEFT results were very reliable, as noted in Table 7. Furthermore, emphasizing these "total validity" coefficients should produce a test with optimal concurrent validity.

Both Form "A" and Form "B" of the FEFT consist of the 35 items designated in Appendix A. The forms each share 15 linking items. Eight of the original 10 linking items were selected, since these items performed well and since more confidence could be vested in their item characteristics given availability of data on these 10 items from all 72 subjects. The remaining seven linking items were the seven items from among the 100 preliminary-study non-linking items that had the highest "total validity" coefficients in the present study.

The present study resulted in two forms of a multiple-choice, machine-scoreable measure of field-independence. The forms contain linking items that can be employed to equate scores across forms given to different samples, or to estimate test-retest reliability if both forms are administered to subjects. The measure should facilitate further research involving this psychological construct, and may provide further insight regarding the nature of this variable.

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Table 1
Item Analysis Data for Form I (n = 19)

Item	Code	Choice Attractiveness A	B	C	D	E	Diff	SD	Intern Valid	Extern Valid	Total Valid
21	60		0.10	**	0.05		0.84	0.38	0.48	0.46	0.63
7	20		**	0.10			0.90	0.32	0.71	0.28	0.61
2	7	**	0.10			0.05	0.84	0.38	0.61	0.24	0.53
35	105			0.05	**	0.05	0.84	0.38	0.39	0.21	0.38
16	46		0.05	0.05	0.10	**	0.79	0.42	0.60	-0.01	0.33
6	18	**	0.26	0.21	0.05	0.16	0.32	0.48	0.12	0.33	0.32
34	100	0.16		**			0.79	0.42	0.29	0.19	0.31
11	35		0.10	0.05	**	0.10	0.74	0.45	0.28	0.18	0.30
5	16*	0.05	0.26	0.16	**	0.16	0.37	0.50	0.14	0.29	0.30
1	6	0.16			0.37	**	0.47	0.51	0.25	0.13	0.24
23	65	**	0.05	0.05		0.05	0.84	0.38	0.43	-0.05	0.21
33	99	0.05	0.05	**	0.05		0.79	0.42	0.44	-0.07	0.20
10	33	0.05	0.05	0.05	**		0.84	0.38	0.35	-0.02	0.19
3	14*	0.16	0.26	0.05		**	0.53	0.51	0.16	0.08	0.15
9	25	0.16	0.16	0.32	**	0.21	0.16	0.38	-0.10	0.27	0.14
24	67*	0.05	0.10	**			0.84	0.38	0.39	-0.14	0.12
28	81	0.10		**			0.90	0.32	-0.26	0.35	0.10
8	24*	0.16		0.10	0.05	**	0.68	0.48	-0.27	0.35	0.09
20	57	**	0.05	0.21	0.05	0.26	0.42	0.51	0.25	-0.10	0.07
32	95*	**		0.05		0.16	0.79	0.42	0.56	-0.32	0.07
27	76*	0.16	0.05	0.32	**	0.05	0.42	0.51	0.16	-0.03	0.07
14	41	**	0.10		0.05	0.10	0.74	0.45	0.35	-0.20	0.06
17	47		**	0.21	0.10	0.56	0.10	0.32	0.15	-0.05	0.05
19	53*			**	0.05		0.95	0.23	0.20	-0.10	0.05
22	62*		0.05	**			0.95	0.23	0.20	-0.10	0.05
15	44			**	0.05		0.95	0.23	-0.06	0.06	0.01
18	52	0.05		**	0.05	0.05	0.84	0.38	-0.14	0.11	0.00
13	40	0.05	0.05		**	0.05	0.84	0.38	-0.06	-0.05	-0.07
29	84*	**	0.10	0.05	0.05		0.79	0.42	0.00	-0.18	-0.13
31	92	0.05			**	0.21	0.74	0.45	0.11	-0.35	-0.19
4	15			0.21	**	0.05	0.74	0.45	0.01	-0.35	-0.24
12	36*	**	0.53	0.16		0.05	0.26	0.45	-0.40	-0.05	-0.27
25	68	**					1.00	0.00	-9.99	-9.99	-9.99
26	74			**			1.00	0.00	-9.99	-9.99	-9.99
30	91					**	1.00	0.00	-9.99	-9.99	-9.99

Note. "Code" indicates the item sequence number from the pool of 110 items. The linking items have "code" sequence numbers designated with asterisks.

Table 2
Item Analysis Data for Form II (n = 20)

		Choice Attractiveness							Intern	Extern	Total
Item	Code	A	B	C	D	E	Diff	SD	Valid	Valid	Valid
28	84*	**	0.10	0.05			0.85	0.37	0.50	0.64	0.66
18	54	0.05	**	0.05	0.10	0.05	0.70	0.47	0.60	0.54	0.64
10	26		0.20	**	0.05		0.75	0.44	0.52	0.54	0.60
6	16*	0.10	0.30	0.15	**	0.10	0.35	0.49	0.52	0.38	0.50
26	76*		0.25	0.15	**	0.10	0.50	0.51	0.45	0.38	0.46
35	106	0.10	0.05		**	0.10	0.70	0.47	0.43	0.37	0.45
12	29	0.10	0.10	0.10	0.55	**	0.10	0.31	0.42	0.32	0.41
17	53*			**		0.05	0.95	0.22	0.23	0.42	0.38
20	62*	0.05		**			0.95	0.22	0.30	0.32	0.35
5	14*	0.05	0.30		0.05	**	0.60	0.51	0.18	0.38	0.33
29	85	**		0.55		0.10	0.35	0.49	0.17	0.34	0.30
15	39		0.10	0.10	**	0.05	0.75	0.44	0.38	0.15	0.28
19	61		**	0.10			0.90	0.31	0.30	0.16	0.25
23	69	0.05		0.05	0.05	**	0.85	0.37	0.21	0.24	0.25
27	77	**	0.05				0.95	0.22	0.30	0.11	0.22
9	24*	0.10		0.05	0.05	**	0.80	0.41	0.22	0.13	0.20
25	75	**		0.10		0.05	0.85	0.37	0.13	0.20	0.19
3	11	0.25	**	0.05	0.10	0.45	0.10	0.31	0.13	0.17	0.17
13	36*	**	0.40	0.05		0.05	0.50	0.51	0.33	0.00	0.16
14	38		**		0.10		0.90	0.31	0.07	0.20	0.16
31	93			0.05	0.05	**	0.90	0.31	0.26	0.01	0.14
16	48		**	0.05			0.95	0.22	0.11	0.11	0.12
21	63	0.05	**			0.05	0.90	0.31	0.11	0.05	0.09
32	94		0.05	0.05	**	0.05	0.85	0.37	0.33	-0.20	0.04
33	95*	**	0.05		0.05		0.90	0.31	0.26	-0.13	0.04
4	12	**	0.15	0.10	0.20		0.50	0.51	0.07	-0.07	-0.01
24	72		0.10	0.05	**	0.20	0.65	0.49	-0.20	0.15	-0.01
34	101	0.05		0.05	0.05	**	0.85	0.37	-0.02	-0.17	-0.12
7	17	0.05		**	0.05		0.90	0.31	-0.02	-0.17	-0.12
2	8				0.05	**	0.95	0.22	-0.20	-0.04	-0.13
1	2	0.05		**			0.95	0.22	-0.20	-0.09	-0.16
22	67*	0.05		**			0.95	0.22	-0.20	-0.19	-0.22
11	28		**				1.00	0.00	-9.99	-9.99	-9.99
8	22		**				1.00	0.00	-9.99	-9.99	-9.99
30	87	**					1.00	0.00	-9.99	-9.99	-9.99

Note. "Code" indicates the item sequence number from the pool of 110 items. The linking items have "code" sequence numbers designated with asterisks.

Table 3
Item Analysis Data for Form III (n = 18)

Item	Code	Choice Attractiveness A	B	C	D	E	Diff	SD	Intern Valid	Extern Valid	Total Valid
12	37	0.06		0.06	**	0.06	0.83	0.38	0.65	0.54	0.63
18	59	0.11	**	0.06			0.78	0.43	0.52	0.59	0.60
31	97	**			0.17		0.83	0.38	0.56	0.48	0.55
2	4	0.06	**	0.11		0.06	0.78	0.43	0.30	0.59	0.50
5	14*	0.11	0.28		0.06	**	0.56	0.51	0.54	0.42	0.50
7	19	**			0.06	0.17	0.78	0.43	0.41	0.51	0.50
34	108	0.11		**	0.11		0.67	0.48	0.47	0.45	0.49
21	67*	0.06		**			0.94	0.24	0.52	0.32	0.44
13	42		**			0.06	0.94	0.24	0.52	0.32	0.44
27	84*	**	0.06		0.06	0.06	0.67	0.48	0.37	0.42	0.43
20	64			0.06	0.06	**	0.89	0.32	0.35	0.41	0.41
9	31		0.11		**	0.11	0.78	0.43	0.22	0.48	0.40
28	88		0.06		**	0.06	0.83	0.38	0.48	0.25	0.37
25	78		0.06	**	0.06		0.89	0.32	0.30	0.37	0.37
29	95*	**		0.06		0.06	0.89	0.32	0.40	0.24	0.32
19	62*	0.06		**		0.06	0.83	0.38	0.27	0.28	0.30
11	36*	**	0.28	0.28		0.06	0.39	0.50	0.34	0.16	0.25
16	53*			**			0.94	0.24	0.20	0.23	0.23
6	16*	0.22	0.11	0.06	**	0.28	0.33	0.48	0.29	0.14	0.22
4	10	0.06	**	0.33	0.17	0.28	0.11	0.32	0.18	0.21	0.21
33	107	0.06		**	0.06		0.78	0.43	0.19	0.18	0.19
23	73	0 11	0.06	**	0.28		56	0.51	0.25	0.08	0.16
8	24*	0.22		0.06			72	0.46	0.10	0.14	0.13
24	76*			0.22	**		0.78	0.43	0.05	0.18	0.13
35	110	0.06	**	0.17		0.17	0.50	0.51	-0.04	0.16	0.08
3	9	0.06	0.06	**	0.06	0.11	0.72	0.46	-0.10	0.14	0.04
26	83	0.11			**	0.11	0.78	0.43	-0.22	0.00	-0.11
32	103	**					0.94	0.24	0.14	-0.28	-0.11
10	34		0.11	0.06	0.11	**	0.67	0.48	-0.50	-0.65	-0.62
22	70				**		1.00	0.00	-9.99	-9.99	-9.99
30	96		**				1.00	0.00	-9.99	-9.99	-9.99
17	55		**				1.00	0.00	-9.99	-9.99	-9.99
14	49					**	1.00	0.00	-9.99	-9.99	-9.99
15	50				**		1.00	0.00	-9.99	-9.99	-9.99
1	3	**					1.00	0.00	-9.99	-9.99	-9.99

Note. "Code" indicates the item sequence number from the pool of 110 items. The linking items have "code" sequence numbers designated with asterisks.

Table 4
Item Analysis Data for Form IV (n = 15)

Item	Code	Choice Attractiveness A	B	C	D	E	Diff	SD	Intern Valid	Extern Valid	Total Valid
21	67*		0.13	**			0.87	0.35	0.46	0.66	0.64
2	5			0.07	**		0.93	0.26	0.56	0.58	0.64
11	32		0.07	**			0.93	0.26	0.57	0.58	0.64
10	30	**	0.07	0.13			0.80	0.41	0.51	0.60	0.63
1	1	0.27				**	0.73	0.46	0.47	0.55	0.57
32	98		0.07		**	0.07	0.87	0.35	0.56	0.47	0.56
14	45	0.07		0.13	**	0.13	0.60	0.51	0.41	0.58	0.56
6	21	0.33	0.13	0.07	**	0.07	0.33	0.49	0.60	0.40	0.54
8	24*	0.07	0.07	0.13	0.07	**	0.67	0.49	0.45	0.52	0.54
18	58	**	0.13	0.07	0.07		0.73	0.46	0.43	0.52	0.53
9	27	**	0.13	0.07	0.20		0.60	0.51	0.48	0.34	0.44
3	13		0.13	**	0.07	0.13	0.67	0.49	0.52	0.27	0.42
4	14*	0.13	0.20		0.07	**	0.60	0.51	0.51	0.26	0.41
22	71		**	0.13		0.07	0.80	0.41	0.30	0.27	0.32
31	95*	**				0.27	0.73	0.46	0.20	0.34	0.31
17	56	0.13	0.33		**		0.53	0.52	0.21	0.31	0.30
23	76*	0.20		0.40	**		0.40	0.51	0.19	0.16	0.20
12	36*	**	0.20	0.13	0.07	0.07	0.53	0.52	-0.05	0.36	0.20
7	23	0.13	**			0.13	0.67	0.49	0.06	0.27	0.19
27	84*	**	0.07				0.93	0.26	-0.02	0.27	0.15
34	104	0.13				**	0.80	0.41	0.18	0.04	0.11
26	82		0.13	0.07		**	0.80	0.41	0.30	-0.22	0.02
5	16*	0.07	0.53	0.27	**		0.13	0.35	0.10	-0.05	0.02
20	66	**	0.07				0.93	0.26	0.10	-0.04	0.02
29	89			**	0.07	0.13	0.80	0.41	-0.22	0.18	0.00
13	43	0.13	0.13	0.07	0.20	**	0.47	0.52	0.16	-0.13	0.00
33	102				**		0.93	0.26	0.17	-0.36	-0.13
35	109	**					0.93	0.26	0.17	-0.36	-0.13
30	90	**	0.40	0.07	0.13		0.40	0.51	-0.16	-0.48	-0.36
25	80	0.07	**	0.40	0.07		0.47	0.52	-0.24	-0.44	-0.38
28	86				**		1.00	0.00	-9.99	-9.99	-9.99
19	62*			**			1.00	0.00	-9.99	-9.99	-9.99
16	53*			**			1.00	0.00	-9.99	-9.99	-9.99
24	79					**	1.00	0.00	-9.99	-9.99	-9.99
15	51			**			1.00	0.00	-9.99	-9.99	-9.99

Note. "Code" indicates the item sequence number from the pool of 110 items. The linking items have "code" sequence numbers designated with asterisks.

Table 5

Item Analysis Responses for Linking Items (n = 72)

Link/ Form	Item	Code	Choice Attractiveness A	B	C	D	E	Diff	SD	Intern Valid	Extern Valid	Total Valid
1							**	0.57	0.50	0.28	0.29	0.32
I	3	14*	0.16	0.26	0.05		**	0.53	0.51	0.16	0.08	0.15
II	5		0.05	0.30		0.05	**	0.60	0.51	0.18	0.38	0.33
III	5		0.11	0.28		0.06	**	0.56	0.51	0.54	0.42	0.50
IV	4		0.13	0.20		0.07	**	0.60	0.51	0.51	0.26	0.41
2						**		0.31	0.46	0.21	0.19	0.22
I	5	16*	0.05	0.26	0.16	**	0.16	0.37	0.50	0.14	0.29	0.30
II	6		0.10	0.30	0.15	**	0.10	0.35	0.49	0.52	0.38	0.50
III	6		0.22	0.11	0.06	**	0.28	0.33	0.48	0.29	0.14	0.22
IV	5		0.07	0.53	0.27	**		0.13	0.35	0.10	-0.05	0.02
3							**	0.72	0.45	0.12	0.27	0.27
I	8	24*	0.16		0.10	0.05	**	0.68	0.48	-0.27	0.35	0.09
II	9		0.10		0.05	0.05	**	0.80	0.41	0.22	0.13	0.20
III	8		0.22		0.06		**	0.72	0.46	0.10	0.14	0.13
IV	8		0.07	0.07	0.13	0.07	**	0.67	0.49	0.45	0.52	0.54
4			**					0.42	0.50	0.20	0.14	0.17
I	12	36*	**	0.53	0.16		0.05	0.26	0.45	-0.40	-0.05	-0.27
II	13		**	0.40	0.05		0.05	0.50	0.51	0.33	0.00	0.16
III	11		**	0.28	0.28		0.06	0.39	0.50	0.34	0.16	0.25
IV	12		**	0.20	0.13	0.07	0.07	0.53	0.52	-0.05	0.36	0.20
5					**			0.96	0.20	0.31	0.17	0.23
I	19	53*			**	0.05		0.95	0.23	0.20	-0.10	0.05
II	17				**		0.05	0.95	0.22	0.23	0.42	0.38
III	16				**			0.94	0.24	0.20	0.23	0.23
IV	16				**			1.00	0.00	-9.99	-9.99	-9.99
6					**			0.93	0.26	0.22	0.15	0.19
I	22	62*		0.05	**			0.95	0.23	0.20	-0.10	0.05
II	20		0.05		**			0.95	0.22	0.30	0.32	0.35
III	19		0.06		**		0.06	0.83	0.38	0.27	0.28	0.30
IV	19				**			1.00	0.00	-9.99	-9.99	-9.99
7					**			0.90	0.30	0.16	0.16	0.18
I	24	67*	0.05	0.10	**			0.84	0.38	0.39	-0.14	0.12
II	22		0.05		**			0.95	0.22	-0.20	-0.19	-0.22
III	21		0.06		**			0.94	0.24	0.52	0.32	0.44
IV	21			0.13	**			0.87	0.35	0.46	0.66	0.64
8						**		0.53	0.50	0.04	0.18	0.17
I	27	76*	0.16	0.05	0.32	**	0.05	0.42	0.51	0.16	-0.03	0.07
II	26			0.25	0.15	**	0.10	0.50	0.51	0.45	0.38	0.46
III	24				0.22	**		0.78	0.43	0.05	0.18	0.13
IV	23		0.20		0.40	**		0.40	0.51	0.19	0.16	0.20
9			**					0.81	0.40	0.24	0.28	0.30
I	29	84*	**	0.10	0.05	0.05		0.79	0.42	0.00	-0.18	-0.13
II	28		**	0.10	0.05			0.85	0.37	0.50	0.64	0.66
III	27		**	0.06		0.06	0.06	0.67	0.48	0.37	0.42	0.43
IV	27		**	0.07				0.93	0.26	-0.02	0.27	0.15
10			**					0.83	0.38	0.09	0.03	0.05
I	32	95*	**		0.05		0.16	0.79	0.42	0.56	-0.32	0.07
II	33		**	0.05		0.05		0.90	0.31	0.26	-0.13	0.04
III	29		**		0.06		0.06	0.89	0.32	0.40	0.24	0.32
IV	31		**				0.27	0.73	0.46	0.20	0.34	0.31

Table 6
Test Difficulties for Forms and Sets of Linking Items

Form	n	Total Form Mean	SD	Linking Items Mean	SD
I	19	25.00	3.77	6.58	1.30
II	20	26.65	3.77	7.35	1.81
III	18	27.11	4.01	7.06	1.98
IV	15	25.60	4.39	6.87	1.41
Total	72	26.11	3.97	6.97	1.65

Table 7
Alpha Reliability Coefficients Across Form Samples or Item Sets

Form	n	GEFT	Both	FEFT
I	19	.85	.78	.64
II	20	.86	.86	.70
III	18	.90	.90	.72
IV	15	.90	.89	.74
Link	72	.88	.80	.43

Note. Forms I-IV consisted of 35 items while the composite data involved all 72 subjects' responses to the 10 linking items.

APPENDIX A
Item Total Validity Coefficients and Map of Use of Items Retained

Item	r		Form	No.	No.
1	0.57		A	1	
4	0.50		A	2	
5	0.64	#	Both	3	1
6	0.24		B		2
7	0.53		A	4	
10	0.21		B		3
11	0.17		A	5	
13	0.42		B		4
14	0.32	*	Both	6	5
16	0.22	*	Both	7	6
18	0.32		B		7
19	0.50		B		8
20	0.61	#	Both	8	9
21	0.54		A	9	
23	0.19		B		10
24	0.27	*	Both	10	11
26	0.60		A	11	
27	0.44		B		12
29	0.41		B		13
30	0.63	#	Both	12	14
31	0.40		A	13	
32	0.64	#	Both	14	15
35	0.30		B		16
36	0.17	*	Both	15	17
37	0.63	#	Both	16	18
38	0.16		B		19
39	0.28		A	17	
42	0.44		A	18	
45	0.56		B		20
53	0.23	*	Both	19	21
54	0.64	#	Both	20	22
56	0.30		B		23
58	0.53		B		24
59	0.60		B		25
60	0.63	#	Both	21	26
61	0.25		B		27
62	0.19	*	Both	22	28
64	0.41		A	23	
67	0.18	*	Both	24	29
69	0.25		A	25	
71	0.32		A	26	
75	0.19		A	27	
76	0.17		B		30
77	0.22		A	28	
78	0.37		B		31
84	0.30	*	Both	29	32
85	0.30		A	30	
88	0.37		A	31	
97	0.55		B		33
98	0.56		A	32	
100	0.31		A	33	
105	0.38		B		34
106	0.45		A	34	
107	0.19		A	35	
108	0.49		B		35

Note. Total validity coefficients for the 10 items previously used as linking items are based on responses of all 72 subjects.